

Reply to Office Action of Feb. 10, 2003

REMARKS

Claims 1-42 are pending in this application. Claim 25 is objected to, claims 1-2, 4-5, 8, 10-23, 26-32, 34-38 and 40-42 are rejected, and claims 3, 6-7, 9, 24, 33 and 39 are withdrawn from further consideration. Claims 11, 36 and 40-41 are canceled, and claims 1, 13, 28, 31, 34 and 35 are amended, hereby.

5 Responsive to the objection to the drawings, a Proposed Drawing Change Request has been submitted herewith. More particularly,

 The Examiner requested Applicant state for the record whether Figs. 7 and 8 depict subject matter that constitutes prior art. Responsive thereto, Applicant submits that Figs. 7 and 8 constitute prior art only in so far as contact is made along the full
10 length of the source stripes or N + channel doping of the devices depicted therein.

 As the Examiner is surely aware, the term “prior art” is a term of art, and as such encompasses a broad range of events and activities, such as, for example, a patent or a printed publication, a public use, or a sale or offer to sell in the United States that precedes by more than one year prior to the date of an application for
15 patent in the United States. Since the term “prior art” encompasses such a wide range of events and activities, Applicant can not attest as to whether the general structure depicted in Figs. 7 and 8, i.e., the “H” pattern wherein the source stripes are connected near their midpoints and the “Z” pattern wherein the head of one source stripe is connected to the tail of a sequential and opposing source stripe, respectively,
20 constitutes prior art. The only portion of the structure depicted in Figs. 7 and 8 to which Applicant can attest to as constituting prior art is the portion of those structure wherein contact is made along the entire length of the source stripes or N+ channel

doping.

Responsive to the objection to the drawings under 37 CFR 1.83(a) for failing to show every feature of the invention specified in the claims, Applicant has amended the claims keeping in mind the comments offered by the Examiner. More particularly, where appropriate the claims have been amended to delete references to a "plurality" of base regions and/or base stripes. The Examiner is also referred to Applicants' response to the claim rejections under 35 U.S.C. §112, second paragraph, that follow hereinafter.

Responsive to the objection to the Specification on the basis of an informality, Applicant has amended the Specification. More particularly, Applicant has amended the paragraph cited by the Examiner to remove an erroneous reference to a gate stripe and substituted therefore the intended reference to a source stripe, thereby eliminating the informality. Accordingly, Applicant submits that the Specification is now in allowable form.

Responsive to the objection to claims 1, 11, 13, 20, 28, 31, 34 and 40 on the basis of various informalities, Applicants have cancelled claims 11 and 40, and have amended claims 1, 13, 20, 28, 31 and 34 keeping in mind the comments offered by the Examiner. Applicant submits that the amended claims are now in allowable form, and respectfully request withdrawal of the objections.

Responsive to the rejection of claim 1 under 35 U.S.C. §112, second paragraph, Applicant has amended the claim to more particularly point out and distinctly claim the subject matter that Applicant regards as the invention. Applicant submits that claim 1 is now in allowable form, and respectfully requests withdrawal of

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the rejection.

Responsive to the rejection of claims 5, 22, 31 and 38 under 35 U.S.C. §112, second paragraph, Applicant submits that one skilled in the art would understand the various structures and methods by which the base stripes or regions are or can be connected together. One example of such a structure is a conventional metal contact layer or runner that electrically connects the base regions, and which is fabricated using conventional and well-known processes. Applicant submits that claims 5, 22, 31 and 38 do particularly point out and distinctly claim the subject matter that Applicant regards as the invention. Accordingly, Applicants submit that claims 5, 22, 31 and 38 are in allowable form, and respectfully requests withdrawal of the rejection.

Responsive to the rejection of claim 13 under 35 U.S.C. §112, second paragraph, Applicant has amended the claim to more particularly point out that the lengths of the channel resistors, and therefore the source stripes, may be different depending upon their location. Generally, shorter lengths closer to the center of the die are preferred. (*see page 10, lines 24-26 of the present specification*). Applicants submit that claim 13 is now in allowable form, and respectfully requests withdrawal of the rejection.

Responsive to the rejection of claim 14 under 35 U.S.C. §112, second paragraph, Applicant submits that the channel resistors offset local decreases in V_{GE} (plateau) by constricting the flow of electron current to smaller areas as temperature increases due to the positive temperature coefficient of the resistor. Increased spacing between source contact regions results in longer source segments. Thus, longer (and therefore larger) contact resistors are defined within the correspondingly longer

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source segments, thereby further offsetting the decrease in V_{GE} (plateau) due to the increased contact resistance. (*page 8, lines 27-31*). Thus, in general, as the length of the source stripe and channel resistors therein increase, the SCIS current density also increases. Applicant does not intend to claim that the source segment length increases with local SCIS current density. To the contrary, Applicant claims that SCIS current density is increased by forming source stripes that are contacted only through periodic source contact regions thereby forming channel resistors within the source stripes between the periodic contact regions. Applicant submits that claim 14 does particularly point out and distinctly claim the subject matter that Applicant regards as the invention. Accordingly, Applicants submit that claim 14 is in allowable form, and respectfully requests withdrawal of the rejection.

Responsive to the rejection of claim 21 and 36 under 35 U.S.C. §112, second paragraph, Applicant respectfully directs the attention of the Examiner to Fig. 9, and submits that by isolating the source stripes from the source metal contact, the resistance of the channels increases. The source stripes 2a and 2b are disposed entirely beneath the dielectric layers 21a, 21b, and are not contacted by the source metal 23. Thus, the only contact to the source stripes 2a, 2b is through the periodic source contact regions 20. As the spacing between the contacts 20 is increased, the resistive drop to the midpoint of the N⁺ contacts and the N⁺ source contact resistance also increases. (*Page 8, lines 11-25 of the present specification*). Applicant submits that claims 21 and 36 do particularly point out and distinctly claim the subject matter that Applicant regards as the invention. Accordingly, Applicants submit that claim 21 and 36 are in allowable form, and respectfully requests withdrawal of the rejection.

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Responsive to the rejection of claim 28 under 35 U.S.C. §112, second paragraph, Applicants have amended claim 28 to more particularly point out and distinctly claim the subject matter that Applicant regards as the invention. Applicant submits that claim 28 is now in allowable form, and respectfully requests withdrawal
5 of the rejection.

Responsive to the rejection of claim 41 under 35 U.S.C. §112, second paragraph, Applicants have cancelled claim 41.

Claims 20, 26 and 35 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,119,153 (Korman, et al.). Applicants respectfully
10 point out that claim 20 and 35 have been amended hereby, and submit that claims 20, 26 and 35 are now in condition for allowance.

Korman, et al., concerns a vertical field effect transistor (FET) having a titanium-silicide source contact layer 158 (*Fig. 1*) that is in electrical contact with source regions 120 and heavily-doped portion 119 along the entire y-axis lengths
15 thereof. The overlying source metallization layer 134 makes ohmic contact with the metal-silicide layer 158 near the center of that layer. (*column 4, lines 49-61*).

In contrast, amended claim 20 recites in part “source contact regions spaced apart from each other along said body stripe and along said source stripes”.

(*Emphasis Added*). Applicants submit that such a structure is not disclosed or
20 suggested by the cited reference, and includes distinct advantages thereover.

The source contact layer of metal silicide in the device of Korman, et al., continuously contacts the body stripe and the source stripes along the entire y-axis lengths thereof. The source contact layer of Korman, et al., is not spaced apart in the

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y-axis direction from other and separate source contact layers. Further, that source contact layer is not spaced apart along the y-axis lengths of the body and source stripes from other source contact layers. Thus, Korman, et al., fails to disclose a device having source contact regions spaced apart from each other along the body stripe and along the source stripes, as recited in part by amended claim 20.

For the foregoing reasons, Applicants submit that the cited reference fails to disclose the subject matter of amended claim 20. Therefore, claim 20, and claims 21-23 and 25-27 depending therefrom, are now in condition for allowance. Accordingly, Applicants respectfully request withdrawal of the rejection and allowance of claims 20-23 and 25-27.

Claim 26 was also rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,119,153 (Korman, et al.). Applicants respectfully point out that claim 26 depends from claim 20, which is in condition for allowance for the reasons given above. Accordingly, claim 26 is also now in condition for allowance which is hereby respectfully requested.

Claim 35 was also rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,119,153 (Korman, et al.). However, claim 35 has been amended hereby to recite in part “source contact regions extending between the base regions and the source stripes, said source contact regions being spaced apart along a length of said source stripes”. (*Emphasis Added*). Thus, claim 35 recites subject matter that is substantially similar to the subject matter recited in claim 20. For the same reasons given above in regard to claim 20 Applicants submit that claim 35, and claims 36-38 and 42 depending therefrom, are now in condition for allowance and respectfully

request same.

Claims 28 and 29 were rejected under 35 U.S.C. §102(b) as being anticipated by the admitted prior art. Claim 28 has been amended to recite in part "source contact regions extending between the base regions and the source stripes, said source contact regions being spaced apart relative to each other and along the base and source stripes". (*Emphasis Added*). Thus, claim 28 recites subject matter that is substantially similar to the subject matter recited in claim 20. For the same reasons given above in regard to claim 20, Applicants submit that claim 28 and claim 29 depending therefrom are now in condition for allowance and respectfully request same.

Claims 1, 2, 4, 8, 11, 13-14, 17-18, 20-21, 23, 26, 35-36, and 37 were rejected under 35 U.S.C. §103(a) as being unpatentable over Applicants admitted prior art (AAPA) in view of U.S. Patent No. 6,060,744 (Kuwahara). Applicants respectfully point out that claims 11 and 36 have been cancelled and claims 1, 13, 20 and 35 have been amended hereby. Applicants submit that amended claim 1, and claims 2, 4, 8, 13-14, and 17-18 depending therefrom, amended claim 20, and claims 21, 23, and 26 depending therefrom, and amended claim 35 and claim 37 depending therefrom, are now in condition for allowance.

Amended claim 1 recites in part "a respective insulating layer over each conductive gate stripe, each insulating layer entirely covering a corresponding one of the source stripes". (*Emphasis Added*). Applicants submit that such a structure is not disclosed or suggested by the cited references, alone or in combination, and includes distinct advantages thereover.

The Examiner states that Figs. 4A, 4D and 5 disclose that insulating layer 21

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covers conductive gate stripes 19a, 19b, and covers the edges of the source stripes proximate the body stripe. To the contrary, Figs. 4A, 4D and 5, and the present specification, disclose that “[i]n a conventional IGBT the source contact metal 40 makes electrical and mechanical contact with . . . inside portions of the source strips [sic] 2a, 2b.” (page 7, lines 13-16 of the present specification, *Emphasis added*).

“The source metal makes contact with the exposed portions of the N+ contact regions and the portions 41a, 41b of the [source] stripes 2a, 2b.” (page 7, lines 21-23 of the present specification). The insulating layer does not cover the edges of the source stripes that are proximate the body stripe. The source stripes are not entirely covered by the insulating layer, nor are the inside edges of the source stripes proximate the body stripe covered by the insulating layer. Thus, AAPA fails to disclose or suggest a respective insulating layer over each conductive gate stripe that entirely covers a corresponding one of the source stripes, as recited in part by amended claim 1.

Kuwahara, et al., is relied upon by the Examiner to show it would have been obvious to one of ordinary skill in the art to modify AAPA by providing a plurality of base regions for increasing the capacity of the device. Kuwahara, et al, does not disclose or suggest source stripes entirely covered by an insulating layer. To the contrary, Kuwahara, et al, discloses that base regions 2 (Fig. 1) and source regions 3 are contacted by main electrode 7. Source regions 3 are not entirely covered by the insulating layer, nor are the inside edges of the source stripes proximate the body stripe covered by the insulating layer. Thus, Kuwahara, et al., fails to disclose or suggest a respective insulating layer over each conductive gate stripe that entirely covers a corresponding one of the source stripes, as recited in part by amended claim

1.

The present invention includes distinct advantages over the cited reference.

The IGBT of the present invention is altered such that contact to the source stripes is made only thorough the source contact regions. As such, prior art techniques that
5 relied upon contacting the source stripes along their entire length are not used. (*page 4, lines 8-11 of the present specification*). The only contact to the source stripes is through the periodic source contact regions. Thus, channel resistors are formed within the source stripes between the periodic source contact regions, and which concentrate current near the source contact regions thereby functioning to offset local
10 decreases in V_{GE} by constricting the flow of current to smaller areas as temperature increases. The V_{GE} plateau is higher and the decay in V_{GE} is non-linear for the channel resistor IGBT design. The SCIS energy density is uniformly higher for the channel resistor IGBT relative to the full channel at all temperatures. (*page 8, 16 through page 9, line 25 of the present specification*).

15 For the foregoing reasons, Applicants submit that no combination of the cited references teaches, discloses or suggests the subject matter of amended claim 1. Claim 1, and claims 2, 4-5, 8, 10, and 12-19 depending therefrom, are therefore in condition for allowance. Accordingly, Applicants respectfully request withdrawal of the rejection and allowance of claims 1-2, 4-5, 8, 10, and 12-19 .

20 Claim 20 was also rejected under 35 U.S.C. §103(a) as being unpatentable over Applicants admitted prior art (AAPA) in view of U.S. Patent No. 6,060,744 (Kuwahara).

However, claim 20 has been amended to recite in part “a respective insulated control

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gate overlying a corresponding base and source stripe and over a corresponding channel region, each control gate including a gate stripe and an insulating layer, said insulating layer entirely covering a corresponding one of said source stripes”.

(Emphasis Added). Thus, amended claim 20 recites subject matter that is

5 substantially similar to the subject matter recited in part by claim 1, which is now in condition for allowance for the reasons given above. For the same reasons given in regard to claim 1, Applicants submit that claim 20, and claims 21- 23 and 25-27 depending therefrom, are also now in condition for allowance. Accordingly, Applicants respectfully request withdrawal of the rejection and allowance of the
10 claims.

Claim 35 was also rejected under 35 U.S.C. §103(a) as being unpatentable over Applicants admitted prior art (AAPA) in view of U.S. Patent No. 6,060,744 (Kuwahara).

However, claim 35 has been amended to recite in part “an insulating layer entirely
15 covering the source stripes and having vias above the source contact regions”.

(Emphasis Added). Thus, claim 35 recites subject matter that is substantially similar to the subject matter recited in part by claim 1, which is now in condition for allowance for the reasons given above. For the same reasons given in regard to claim 1, Applicants submit that claim 35, and claims 37-38 and 42 depending therefrom, are
20 also now in condition for allowance. Accordingly, Applicants respectfully request withdrawal of the rejection and allowance of the claims.

Applicants acknowledge and appreciate the indication by the Examiner that claim 25 would be allowable if rewritten in independent form and to include all the

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limitations of its base claim and any intervening claims. Similarly, Applicants
acknowledge and appreciate the indication by the Examiner that claims 5, 10, 12, 15,
16, 22, 30-32, 34, 38 and 42 would be allowable if rewritten in independent form and
to include all the limitations of its base claim and any intervening claims. Applicants
5 respectfully request consideration of the amended claims by the Examiner prior to
rewriting in independent form the claims indicated as allowable.

For all the foregoing reasons, Applicants submit that the pending claims are
definite and do particularly point out and distinctly claim the subject matter which
Applicants regard as the invention. Moreover, Applicants submit that no combination
10 of the cited references teaches, discloses or suggests the subject matter of the pending
claims. The pending claims are therefore in condition for allowance, and Applicants
respectfully request withdrawal of all rejections and allowance of the claims.

The Examiner is invited to telephone the undersigned in regard to this
Amendment and the above identified application.

Respectfully submitted,

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Date


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